Perceptions and physical realities of flood risk in Cerro Punta, Chiriquí, Panamá

Julia Stanganelli
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Perceptions and physical realities of flood risk in Cerro Punta, Chiriquí, Panamá

Julia Stanganelli

SIT Panama Fall 2018: Tropical Ecology, Marine Ecosystems, and Biodiversity Conservation
Abstract

Flooding is an issue of increasing global importance. With climate change and land-use alteration affecting hydrological cycles globally, certain regions of the world are experiencing more frequent or severe flooding. In the Chiriquí Province of Panamá, the town of Cerro Punta has been subject to several severe flooding events in the last few decades. This study aimed to understand perceptions of flood risk amongst residents of Cerro Punta, as well as evaluate physical flood risk in the area. Residents were interviewed regarding their perceptions of flooding as an increasing issue, possible causes, vulnerable areas and populations, and preparedness for future disasters. ArcGIS was also used to map flood vulnerability based on the proximity of buildings to rivers. Overall, residents felt that flooding was an issue of increasing concern in the area, and that deforestation and issues surrounding it was a large driver. Many areas of Cerro Punta were perceived as vulnerable, with the overarching theme of lower areas closer to rivers being the most at risk. Through ArcGIS, it was found that a significant number of buildings in the town are within close proximity to rivers. Overall, residents did not feel that the town is prepared to deal with future flooding, and many cited a general lack of awareness amongst residents. Further research should examine the relationship between geographical vulnerability and socioeconomic status of populations. The paradox between the majority opinion that flooding is a serious issue and the general claim of a lack of awareness in the rest of the community should also be explored.
Acknowledgements

I would like to extend my greatest gratitude to those people that have made this study possible. I would first like to thank Damaris for allowing me to stay at FUNDICCEP in Cerro Punta while collecting data, and for going above and beyond to help me find contacts and gather information surrounding my project. I would also like to thank Aly, for being an amazing advisor and mentor throughout this project and this semester. My time in Panama truly would not have been the same without her guidance. I would like to thank all of those who participated in my study, and for allowing me to hear their perspectives and opinions. I would like to thank my friend Nina for her constant GIS assistance and emotional support from 1,000 miles away. Lastly, I would like to thank my friends who have helped me translate Spanish conversations, had a shoulder to lean on during rough days, and who have simply been there to laugh with over the past month.
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Introduction

Flood Risk, Vulnerability, and Management

Flooding is defined as the impermanent covering of land by water outside of its usual parameters (Schanze 2006). Globally, flooding is considered to be one of the most detrimental types of natural disasters. Several million people worldwide are affected each year by floods, in both coastal and inland areas (Jongman et al. 2012). The impacts on human communities and the economic toll of damages caused by flooding make it one of the most significant environmental hazards faced by humans (Kellens et al. 2011).

Flooding can refer to coastal flooding, caused by a variety of forces such as hurricanes and tsunamis, or flooding of fluvial systems (Jongman et al. 2012). In scientific literature, coastal flood risk and damage assessments have traditionally received more attention than riverine flooding. Studying coastal flooding can be more accessible, as coastal flood zones are relatively easy to map in comparison with that of river basins (Jongman et al. 2012). Additionally, coastal zones globally house a large and growing segment of the human population, as well as many of the world’s largest and most economically viable cities, and thus the incentive to study and manage risks in these areas is very high (Small and Nicholls 2003).

With coastal flooding receiving more attention worldwide, there is a need for more research surrounding the risks and impacts associated with fluvial flooding, and the vulnerabilities of populations in hazardous areas.

River flooding is generally defined physically by hydrological variables such as water level and river discharge. The damage from floods, however, must be examined in terms of both physical and societal variables in an area (Merz et al. 2010). For example, a certain level of river discharge may constitute a highly damaging flood in an area with a considerable human population or infrastructure surrounding it, but in another area it may not. Additionally, various features of a river basin can play key roles in the damage caused by flooding. This can include the topography and elevation of the river basin, the spatial distribution of vegetation, and flow characteristics of the river. An additional issue related to river flooding is the occurrence of rainfall-induced landslides. This can be caused by many of the same conditions that create river flooding, such as high-intensity rainfall, and, especially in river basins with topographical and vegetative conditions allowing it, can cause immense damage as well (Guzzetti et al. 2008).

Flood risk management addresses a wide variety of concerns and processes both before and after flooding has occurred. Management can constitute the prediction of flood hazards, measures taken to mitigate or prevent flooding, risk reduction, and all aspects of disaster response (Schanze 2006). Within disaster risk management, a variety of terms such as hazard, risk, and vulnerability are frequently used. Hazard is defined as the capability of an event to cause harm. For example, river flood hazard could refer to the probability of high river discharge to occur (Merz et al. 2010). Vulnerability, in turn, characterizes the potential of something to be harmed, based on its inherent properties, susceptibility, and values. This can be further separated into differing categories such as social and cultural vulnerability, based on the human impacts of a potential event, economic vulnerability, based on the financial or asset losses incurred, and ecological vulnerability, referring to the environmental impacts (Schanze 2006). Vulnerability can also include the response capacity of an element or population to a potential disaster, meaning that those with a lower capacity to effectively respond to an event are thus more vulnerable (Merz et al. 2010). Risk, then, is defined in terms of both hazard and vulnerability.
Flood risk refers to the probability of harm being caused by a flooding event, and depends on both the hazards involved and the vulnerability of the populations or elements at hand to those hazards (Schanze 2006). Risk analysis has come to form the basis for flood management decisions in recent years (Merz et al. 2010). Thus, having an understanding of the flood risk in an area is crucial in order to effectively prevent, prepare for, and respond to flooding disasters.

**Role of GIS in Disaster Risk Prevention**

An important component in disaster risk management and prevention is the use of technologies such as Geographical Information Systems (GIS). GIS is becoming increasingly prevalent in the realm of disaster management, with uses in various phases of emergency management, such as mitigation, preparedness, response, and recovery. One of the most critical uses of GIS in terms of prevention and preparedness of disasters is in exposing the varying spatial distributions of risk through mapping both hazard and vulnerability (Cova 1999). Using GIS, maps can be drawn with topographic and physical parameters illustrating risk, and can also include the persons or infrastructure in an area to analyze vulnerability in a multi-faceted way (Plate 2002). Additionally, mapping in this way can provide an excellent avenue of communication with the local community, as potential hazards can be visually shown with little need for specialized knowledge to interpret. A case study of flood risk mapping in Vietnam, for example, displayed how GIS can be used to evaluate risk of damage caused by disasters, while incorporating local knowledge into the mapping to further expose vulnerabilities and provide avenues for management (Tran et al. 2009).

**Flooding, Deforestation, and Climate Change**

In recent years, the intensity and frequency of extreme weather events, and hydrological events in particular, have been shifting worldwide. In various regions of the world, patterns of flooding and droughts have been intensifying, in part due to climate change. The increasing of temperatures worldwide has been shown to increase precipitation while decreasing evapotranspiration, which will increase river discharge on a global scale (Hirabayashi et al. 2008). Not only has global warming increased the amount of precipitation worldwide, but it is also changing the nature of that precipitation. According to Trenberth et al. (2003), climate change impacts the intensity, frequency, and duration of precipitation events locally. In many areas, rainfall intensity will increase as rainfall rates increasingly exceed evaporation rates, due to increased moisture in the atmosphere (Trenberth et al. 2003). Intense rainfall can have consequences such as increasing river discharge over short periods of time, which can lead to flash flooding, as well as landslides.

In addition to the changes brought on by climate change, land use alteration also has the potential to not only affect hydrological cycles on a large scale, but also to impact the spatial distribution and intensity of surface runoff on a smaller scale. There has been an ongoing debate within the scientific community over the effect of forest cover on flood frequency for roughly the last century (Van Dijk et al. 2009). Surface runoff, very closely related to river discharge, depends on both precipitation and evapotranspiration. Theoretically, deforestation leads to lower levels of evapotranspiration, which would then increase runoff and river discharge. There is evidence that deforestation in particular can contribute significantly to flood risk in the developing world, with the frequency of flooding increasing as forest area cover decreases.
(Bradshaw et al. 2007). Additionally, the validity of this claim has also been supported by multiple studies, including one on the hydrological cycle in Amazonia, in which regional deforestation was shown to contribute to periods of higher precipitation (Almeida et al. 2007). Similarly, a study conducted in Malaysia showed the deforestation of tropical forests for oil palm plantations to be associated with increased flooding events (Adnan et al. 2016). However, various studies have disputed the claims of this forest-flood hypothesis, and in particular the findings of Bradshaw et al. (2007). There are claims that it is too difficult to separate the effects of deforestation on a large scale from the effects of variations in climatic trends, and thus the forest-flood hypothesis is unsupported (Van Dijk et al. 2009).

Whether or not this hypothesis can be supported on a large scale, deforestation has the potential to affect the spatial distribution of runoff in smaller contexts. Deforestation is often associated with a reduction in soil infiltration capacity, which can increase peak flows within a basin considerably (Van Dijk et al. 2009). Additionally, in sloping areas, deforestation can significantly contribute to erosion, which has been shown to directly contribute to landslides (Pradhan et al. 2012). Especially with increasing intensity of rainfall, this can create very dangerous conditions in certain areas.

Flood Risk and Environmental Justice

Along with these changing hydrological cycles comes the need to examine the vulnerability of various populations to increasing environmental risk. Environmental inequality or environmental injustice is defined as the reality that certain groups of people may be more greatly impacted by or more vulnerable to certain environmental disasters and phenomena than other groups (Brulle and Pellow 2006). Traditionally, environmental injustice has been categorized by distributional discrimination, in which certain groups of people, namely people of color, are more vulnerable than the general population due to proximity to waste sites, landfills, and other types of sites that would have a negative impact on human health (Walker 2009). This is also commonly referred to as environmental racism, a term that gained popularity due to a 1983 study that provided evidence that a disproportionate amount of African American communities in the southern United States contained waste sites (Brulle and Pellow 2006).

In recent years, the environmental justice framework has expanded to include an increasingly diverse set of concerns. Beyond environmental racism, environmental justice has come to more generally include populations belonging to certain demographic groups or that are socioeconomically disadvantaged for a variety of reasons. Issues incorporated include unequal vulnerability to food insecurity, access to transportation, and flood disaster risk, which became a large part of the environmental justice movement following Hurricane Katrina in the United States in 2005 (Walker 2009).

Nicknamed the “Unnatural Disaster”, Hurricane Katrina garnered attention within the environmental justice movement, in both the inequality of the damage done by the hurricane itself, and in the disaster response by the local, state, and federal government, which has received heavy criticism. In a book published in 2009 by Levitt and Whitaker, various levels of complexity that make this disaster “unnatural” are explored. Before Hurricane Katrina, the population of New Orleans was already highly segregated by race and class, with disproportionately high percentages of both African Americans and those living below the poverty line inhabiting the topographically lowest and most at-risk of flooding areas of the city. According to Levitt and Whitaker, it is this differential vulnerability, along with the failure of
government officials to adequately prepare or protect the most vulnerable segments of the population, that makes Hurricane Katrina such an important case study in environmental inequality (Levitt and Whitaker 2009).

Beyond New Orleans, differential vulnerability to flood risk has accrued increasing concern in other areas of the world as well. One study conducted in the United Kingdom in 2011 showed that a disproportionate percentage of the people living within coastal flood zones were from more impoverished segments of the general population (Walker and Burningham 2011). Additionally, in a study conducted in Bangladesh, a country extremely prone to flooding, it was found that there is a significant positive correlation between the distance that people live from the Meghna River, used as an indicator of risk, and their household income (Brouwer et al. 2007). Thus, in areas where certain populations are more geographically vulnerable to disasters such as flooding, it is important to also examine potential differences in socioeconomic or demographic vulnerability, in an environmental justice framework. It is crucial to assess these vulnerabilities even before a disaster has taken place, as it is the pre-disaster conditions that can render some groups within a community at a higher risk than others (Kapucu 2008).

*Community Role in Disaster Risk Prevention*

While governments and emergency managers and responders are often the primary actors in both prevention of and response to disasters, the community affected plays a vital role in each of these areas. Public preparedness and coordination between community and organizational actors can lead to more effective emergency response operations, reducing loss of human life and damage inflicted in a disaster scenario (Kapucu 2008). Kapucu (2008) acknowledges that achieving public participation in disaster preparedness is extremely difficult, as the general attitude of the public in these cases is often apathetic. This apathy or complacency can stem from a lack of knowledge about the threats being faced, repeated warnings of which came little danger, or belief that government recommendations on preparation or response are either ineffective or unachievable (Kapucu 2008). According to Qureshi et al. (2006), awareness is the largest roadblock to public participation in disaster preparedness, and that in order to achieve community engagement, the public must be perceive and care about the threats at hand (Qureshi et al. 2006). In this way, public perceptions of risk and disaster preparedness and management are intrinsically linked.

In order to effectively prepare for or respond to a disaster, perceptions of the risks and threats faced by the community must be understood. Studying risk perception of the public can include examining people’s awareness of threats, their emotional response, and their behavior with respect to hazards. According to Kellens et al. (2011), studying and having a knowledge of people’s risk perceptions is a necessary precursor to communicating effectively about risk (Kellens et al. 2011). With communication between the public and emergency managers being essential to prevent and prepare for potential future disasters, public perceptions of risk should be given close attention.

*Study Site: Cerro Punta, Chiriquí, Panama*

One region in which flood risk is of increasing concern is the Chiriquí province of Panama, and the town of Cerro Punta in particular, which is the focus of this study. Cerro Punta is located in the Tierras Altas region of Panama, and sits at an altitude of 2,000 meters above sea
level. The climate is tropical and consists of a rainy and dry season. Chiriquí is the highest province in Panama, and Cerro Punta is the highest town in this province. The terrain is fairly rugged and mountainous, characterized by steep slopes cut by valleys with major rivers, such as the Chiriquí Viejo River, running through them. The region, and Cerro Punta in particular, is highly agricultural, and much of the previously forested land surrounding the town has been converted to farmland over roughly the last century (Participant #19, personal communication, Nov. 19, 2018). In this highly agricultural region, climate change has occurred at the local level, with farmers reporting increased periods of drought along with periods of high intensity rainfall (Hobeika and Wagner 2018). Many believe that land use change has also contributed to the recent frequency of flooding, with deforestation for agricultural expansion being one of the largest threats to conservation in the region (Connelly and Shapiro 2006). According to one study conducted on watershed management in the region, the conversion of land from forest to pasture can increase surface flow of water, increasing the occurrence of flooding events (Wishnie and Socha 2003).

With flooding being of increasing concern in the region, it is necessary to assess the vulnerability of various groups to such environmental risks. According to the May 2014 Management Plan for the Chiriquí Viejo River Basin published by the Autoridad Nacional de Ambiente in Panama, indigenous people represent 20% of the population in the region, and are traditionally the most vulnerable social group (Autoridad National del Ambiente 2014). Additionally, studies have shown that in general, geographical regions that are the most vulnerable to the impacts of climate change are also the traditional lands of indigenous communities (Tsosie 2007). There is currently a lack of evidence to determine whether certain groups of people, such as indigenous migrant workers, in the town of Cerro Punta are disproportionately vulnerable to environmental risks. Populations of varying socioeconomic levels have been shown to be differentially vulnerable to flood risks, as discussed previously. It is important to assess the perception of flood risk of the general population, as well as populations that may be more vulnerable, as flood risk perception has been shown to correlate greatly to disaster preparedness (Miceli et al. 2008).

Study Aim

This study aims to evaluate community perceptions of flood risk, in terms of past experiences with flooding and perspectives on the issue of flooding in the present day. Community perceptions regarding differential vulnerability to flood risk, both geographically and demographically will be examined, as will opinions on preparedness for potential future disasters. Additionally, physical risk will be evaluated using GIS mapping for Cerro Punta based on the proximity of houses and buildings to major rivers. It is hoped that this study will provide insight into differential vulnerability amongst residents of Cerro Punta to flood risk, as well as the community’s preparedness for future flooding and thus the potential impacts that this could have.

Research Question

How do residents of Cerro Punta, Panama perceive flood risk in their homes and in their community, and what is the physical flood risk in the area?
Methods

Interview Methods

Residents of Cerro Punta as well as a few persons living outside of Cerro Punta but working within or closely with the town were interviewed. Twenty interviews were conducted in total. Interviewees included storeowners, farmers, governmental employees, and employees of non-governmental organizations. The aim was to survey a sample of people from varying backgrounds and varying perspectives, living in various areas of Cerro Punta.

To find participants, a combination of convenience sampling and the snowball method was used (Bernard 2018). Using the convenience method, participants were located outside of the grocery store in Cerro Punta center, as well as at various stores and vegetable and fruit stands around the town. A combination of customers as well as vendors and storeowners were interviewed in this way. The snowball method was used to identify other potential participants. After scheduling interviews with an employee at a local non-governmental organization, information on more contacts for various farmers and employees at other NGOs and governmental employees were obtained. The snowball method was then used to obtain more information from there. For contacts obtained in this way, I scheduled interviews in which I offered to meet participants at their homes, offices, or in a neutral location. Additionally, based on geographical information obtained from the interviewees, areas of Cerro Punta were identified in which further convenience sampling was conducted, in order to interview residents from as many areas as possible.

Based on the setting of each interview, either an unstructured or semi-structured interviewing method was used (Bernard 2018). For interviews that occurred in a casual setting like the grocery store, unstructured interviewing was used, with a set of roughly 8 questions prepared (Appendix A). Some questions were omitted in some cases based on answers to previous questions. For example, if an interviewee answered that they did not believe flooding was an issue in the area, I did not ask them what they believed the causes of flooding in the region to be. For scheduled interviews, a semi-structured method was used, with a set of 10 questions that were more strictly adhered to. Notes were taken while the interview took place, and the conversation was recorded if it was okay with the participant.

GIS Methods

For the GIS portion of the study, Open Street Map was used to gather vector data on the Panamanian provinces and corregimientos, rivers, roads, and buildings. The town of Cerro Punta was identified and the corregimiento boundary was digitized, including towns just outside of Cerro Punta, but inside the corregimiento, such as Paso Ancho. Flood risk was analyzed using a buffer analysis of building proximity to rivers within the corregimiento in ArcGIS 10.6 (Sutton et al. 2009). Buildings within a 10, 25, 50, and 100m buffer of the river were extracted. The percentages of buildings in Cerro Punta within each of these distances of a river were calculated.

Ethics

The proposed research for this study was approved by both the Local Review Board (LRB) and the SIT Institutional Review Board (IRB). Particularly with human subjects research,
this process is essential to ensuring the safety and protection of human participants form any types of harm.

Prior to beginning each interview, an informed consent process was conducted. Using the informed consent script (Appendix B) as a guide, each participant was asked to give their verbal consent. Each participant was ensured that their participation was completely voluntary, that they could stop the interview at any point if they so chose, and that they did not have to answer any questions that they did not want to. Additionally, each participant was informed that their name or other identifiable information would not be sued, and that their responses would not be shared outside of the study.

**Results & Discussion**

**Background on Study Participants and Flood Experiences**

Study participants resided in various areas and communities within and outside of the town of Cerro Punta. Eight different neighborhoods considered within the town of Cerro Punta were represented by participants, with the majority being from the community of Guadalupe (Figure 1). Additionally, one participant was from the town of Paso Ancho, just outside of Cerro Punta, which was included in analyses due to its close proximity. Two participants resided in locations outside of the study scope of Cerro Punta, but their responses were included, as they worked within and with the town.

A variety of professions was seen amongst study participants, which were separated into seven occupational categories (Figure 2). The largest percentages of participants worked in agriculture and were vendors or storeowners. Additional participants worked for non-governmental organizations, in parks and ecotourism, healthcare, governmental professions, and were homemakers. A goal of the study was to gain perspectives from residents of Cerro Punta with varying backgrounds. Inherently in the methods used, some participants were chosen specifically because of their profession, but not all were.

Study participants were asked if they experienced flooding in their respective areas in a series of years when Cerro Punta was known to have major flooding events. Additionally, participants were asked if they remember experiencing flooding in any additional years. According to responses from participants, the year in which flooding affected the most areas was this year (2018), in the months of June and July. As stated by many participants, the largest cause of damage in this year was not the excess water or force of the river itself, but rather landslides caused by intense rain. In other years, the largest causes of damage cited by many participants are that of the rivers and roads flooding. Additionally, participants reported experiencing flooding in 2008 and 2014, but also in other years beginning in the 1970s, 2006, 2010, 2016, and 2017.

Recalling the severity of these incidences of flooding, participants shared their varying perspectives on the damage caused. According to one participant, the flooding of the rivers that was experienced in the 1970s was in some ways more severe than the flooding of recent years, but the damage caused was less, as there were less people living and working down by the rivers at that time (Participant #4, personal communication, Nov. 10, 2018). Another participant recalled an incidence of flooding in the year 1970 in which his house was swept into the river in Paso Ancho (Participant #9, personal communication, Nov. 15, 2018). More recently, multiple participants recalled an incident in 2014 in which a portion of the main road in between Bambito
and Cerro Punta Centro collapsed due to the force of a growing river, and a bus carrying passengers was swept into the river, causing multiple fatalities.

Due to the nature of the methods used in this study, asking participants to recall incidences of flooding from their memory, there may be error in both the years cited by participants, as well as the severity and damage caused described by each participant. This account of past flooding events is not meant to serve as a definitive timeline of flooding in Cerro Punta, but rather as a collective narrative of experiences as remembered by Cerro Punta residents. This serves to set the frame for the perspectives of these residents on flooding as a growing issue in the area, opinions on what is contributing to and driving flooding, geographical and demographical vulnerability and risk, and responsibilities and actions taken in terms of preparation for and prevention of future disasters by the government, non-governmental organizations, the community, and individuals.

![Community Representation of Participants](image1)

**Figure 1: Community representation of participants within the study.**

![Occupations of Participants](image2)
Participants in the study were asked for their opinions on whether flooding was a growing issue in Cerro Punta, and if so, what they thought to be some of the drivers or causes of flooding and the damage caused by flooding. The results of the former part of the question can be seen in Table 1. In terms of flooding as a growing issue, 85% of all respondents stated that either yes, it is an issue of increasing importance, or that they believe the issue has always been of grave significance. The other 15% of respondents stated either no, the issue is not of growing importance, or that the level of risk has always been low.

Separated by occupation, those participants who work in agriculture had the lowest instance of belief that the issue is of growing importance, with 71% of respondents sharing this sentiment. With that being said, those working in agriculture also made up the largest proportion of participants to begin with, and the participants were not selected randomly. A larger, randomly selected, and more evenly distributed sample in terms of occupation would be needed to accurately analyze this finding. When separated by geographical area, it was revealed that 100% of respondents in the areas of Bajo Grande, Guadalupe, Bambito, Alto Pineda, La Filipina, Las Nubes, Paso Ancho, and those from outside of Cerro Punta believed flooding to be an issue of growing importance while only 50% of respondents from Cerro Punta Centro and 0% of respondents from Nueva Suiza shared this belief. As discussed later, Cerro Punta Centro and Nueva Suiza are areas that no participants cited as vulnerable (Table 3). It may be the case that the respondents from these areas perceive less flood risk in Cerro Punta in general because they are less vulnerable to flooding in their respective geographical locations.

Participants who responded that they believed flooding to either be of increasing importance, or of similar but significant importance as in past years were further asked what they believed to be some of the drivers of this issue. Responses varied, but many commonalities were observed (Table 2). To begin, almost all respondents (88%) cited or mentioned deforestation in some capacity as a major contributor to flooding and the damage caused by flooding in the region. While deforestation is in many ways tied to agriculture in the area, with forests being cleared for farmland, only six of the 15 respondents who cited deforestation as a cause specifically blamed agriculture by name. Of those 15 respondents who mentioned deforestation as a driver, many more specifically described the negative effects of deforestation that they believe are contributing to the issue. The most common reason given was the dumping of trees, coupled with the disposal of trash, into rivers, blocking the flow of water and thus creating dangerous conditions in the case of a heavy rain. Multiple participants described instances of this in which trees and trash created reservoirs that then broke under heavy river flow caused by intense rain, causing damage downstream.

Other common reasons given as to why deforestation and agriculture could be contributing to flood risk in Cerro Punta were erosion of the land, particularly in high areas, with mentions from five respondents, and a reduction in the soil infiltration capacity, mentioned by two respondents. Similarly, two respondents stated that the presence of large areas of greenhouses has also reduced the area of the soil available to absorb rain water, and has contributed to the accumulation of vast quantities of water in specific places. Additionally, almost half (47%) of respondents mentioned increasing or more intense periods of rain as a
contributor to flooding, with two of these respondents specifically mentioning climate change along with increasing rain as a cause. Four respondents specifically stated that the building of houses in dangerous areas, specifically too close to rivers and too far up in the mountains, has contributed greatly to the damage caused by river flooding and landslides caused by intense rain. Three respondents placed blame on the lack of awareness within the community about the risks and dangers associated with flooding for damage caused by recent disasters.

Table 1: Responses to the question “Is flooding an increasing problem in the area?” Responses were grouped based on whether they were positive (belief that flooding is an increasing issue, or an issue that has always been important), or negative (belief that flooding is not an increasing issue, or that it has never been an issue). The proportions of respondents that answered positively and negatively were separated by occupation as well as by geographical area.

<table>
<thead>
<tr>
<th>BY OCCUPATION</th>
<th>“Yes” or same (high) importance</th>
<th>“No” or same (low) importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td>85%</td>
<td>15%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>71.43%</td>
<td>28.57%</td>
</tr>
<tr>
<td>Store owner or vendor</td>
<td>83.33%</td>
<td>16.67%</td>
</tr>
<tr>
<td>NGO</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Government</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Parks and ecotourism</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Healthcare</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Homemaker</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BY AREA</th>
<th>“Yes” or same (high) importance</th>
<th>“No” or same (low) importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bajo Grande</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Guadalupe</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Nueva Suiza</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Cerro Punta Centro</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Alto Pineda</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>La Filipina</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Las Nubes</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Paso Ancho</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Outside of Cerro Punta</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 2: Causes of flooding mentioned by participants. The number of times each cause was mentioned and the percent of participants to mention each is shown.

<table>
<thead>
<tr>
<th>Causes mentioned</th>
<th>Number of times mentioned</th>
<th>Percent of participants to mention cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deforestation</td>
<td>15</td>
<td>88.24%</td>
</tr>
<tr>
<td>Dumping of trees and/or trash</td>
<td>9</td>
<td>52.94%</td>
</tr>
<tr>
<td>Increasing amount and/or intensity of rain</td>
<td>8</td>
<td>47.06%</td>
</tr>
</tbody>
</table>
Agriculture & 6 & 35.29% \\
Erosion & 5 & 29.41% \\
Building in dangerous areas & 4 & 23.53% \\
Lack of awareness & 3 & 17.65% \\
Soil infiltration capacity & 2 & 11.76% \\
Climate change & 2 & 11.76% \\
Greenhouses & 2 & 11.76% \\
Topography & 1 & 5.88% \\

Geographical and Demographical Vulnerability and Risk

Perspectives on both the geographical and demographical vulnerability of residents of Cerro Punta in terms of flood risk were gathered. Participants were asked if they believe that there are areas of the town that are more vulnerable than others, and if so, what areas. Responses to this question included both the names of specific neighborhoods and communities within Cerro Punta, as well as general areas like “close to rivers” and “close to hills”. Out of the areas of town mentioned, Las Nubes and Guadalupe were the most frequently cited as vulnerable, with Bajo Grande and Bambito also being mentioned by a significant portion of participants. It should be noted that certain areas included in the study scope, such as Bambito and Paso Ancho, may fall “outside” of Cerro Punta in the minds of participants, and may not have been considered in their responses. Two respondents stated that they believe everywhere in Cerro Punta is vulnerable to flooding, and did not mention any areas in particular that were at higher risk than others. Two respondents also stated that they don’t believe any areas are particularly vulnerable. These respondents reside in Nueva Suiza and Cerro Punta Centro, two areas that no participants mentioned as being vulnerable.

In addition to the perspectives garnered by residents on geographical vulnerability, physical risk for the town was assessed using ArcGIS technology (Figures 3-7). It was found that within the corregimiento boundaries of Cerro Punta, 116 buildings (0.0028%) are within 10 meters of a river, 328 (0.0080%) are within 25 meters, 650 (0.016%) are within 50 meters, and 1099 (0.027%) are within 100 meters. These are likely underestimates of the percentages of buildings actually within these distances of rivers, as it is highly likely that there is a significant number of buildings within Cerro Punta not detected by Open Street Map. Despite this likely source of error, it was shown that a significant number of buildings and houses within Cerro Punta lie within close proximity to rivers. As discussed previously, this is considered by many to be the most dangerous zone in which to live.

Participants were also asked if they believed that any groups of people were more vulnerable than others in terms of flood risk. Most respondents were either confused by this question, or gave an answer similar to the previous question, and stated that people who live close to the rivers and hills are at higher risk than the general population. However, two of the respondents stated that they believe the indigenous migrant worker population is more vulnerable to future flooding than the rest of the community. Both of these respondents work for environmentally-focused NGOs. One respondent articulated that this vulnerability is two-fold: it comes partially from the locations of their houses, which are often built on the farms that they work for, and located very close to dangerous rivers, but it also comes with the anonymity of many of the migrant workers. They stated that many times the names of the workers are not even
known by the farms that they work for, making it difficult to contact or identify them in cases of
emergency. This was the case with a young man that was killed by a landslide in Bajo Grande in
the summer of 2018 (Participant #10, personal communication, Nov. 15, 2018).

While data on socioeconomic status was not gathered from participants, previous studies
have shown that those people who are geographically more vulnerable to natural disasters such
as flooding can come from disadvantaged economic and social groups (Levitt and Whitaker
2009, Walker and Burningham 2011). Specifically, Brouwer et al. (2007) found a significant
positive correlation between the distance people lived from a river and their household income
(Brouwer et al. 2007). It may be the case that in Cerro Punta, the people who live closest to
rivers are socioeconomically disadvantaged, and disproportionately at risk of future flooding.
Further research would need to be done to support this correlation.

Table 3: Vulnerable geographical areas of Cerro Punta, based on interview responses. The
number of times each area was mentioned and the percent of participants who mentioned that
area are shown.

<table>
<thead>
<tr>
<th>Vulnerable Areas</th>
<th>Times mentioned</th>
<th>Percent of participants who mentioned area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Las Nubes</td>
<td>10</td>
<td>55.56%</td>
</tr>
<tr>
<td>Guadalupe</td>
<td>9</td>
<td>50%</td>
</tr>
<tr>
<td>Bambito</td>
<td>6</td>
<td>33.33%</td>
</tr>
<tr>
<td>Bajo Grande</td>
<td>6</td>
<td>33.33%</td>
</tr>
<tr>
<td>La Filipina</td>
<td>2</td>
<td>11.11%</td>
</tr>
<tr>
<td>Entre Rios</td>
<td>1</td>
<td>5.56%</td>
</tr>
<tr>
<td>Nueva Suiza</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Cerro Punta Centro</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Alto Pineda</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Paso Ancho</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Close to rivers</td>
<td>8</td>
<td>44.44%</td>
</tr>
<tr>
<td>Close to hills</td>
<td>4</td>
<td>22.22%</td>
</tr>
<tr>
<td>Everywhere</td>
<td>2</td>
<td>11.11%</td>
</tr>
<tr>
<td>No vulnerable areas</td>
<td>2</td>
<td>11.11%</td>
</tr>
</tbody>
</table>
Figure 3: Rivers of Cerro Punta.
Figure 4: Buffer zone of 10 meters, focused on the neighborhood of Guadalupe. The buildings within 10 meters of the river are highlighted in blue.
Figure 5: Buffer zone of 25 meters, focused on the neighborhood of Guadalupe. The buildings within 25 meters of the river are highlighted in blue.

Figure 6: Buffer zone of 50 meters, focused on the neighborhood of Guadalupe. The buildings within 50 meters of the river are highlighted in blue.
Figure 7: Buffer zone of 100 meters, focused on the neighborhood of Guadalupe. The buildings within 100 meters of the river are highlighted in blue.
A key motivation for this study was to evaluate the preparedness of Cerro Punta to deal with future flooding from the perspectives of residents of the town and those who work within the government, non-governmental organizations, and others. Participants were asked whether they believed that the town of Cerro Punta was prepared to deal with potential future flooding, and additionally, in the semi-structured interviews, participants were also asked what is being done to prevent and prepare for future disasters by the government, non-governmental organizations, and the community in general. Nearly all participants stated that they do not believe that Cerro Punta is prepared to deal with potential future flooding, with only one participant stating the opposite (Table 4).

A variety of reasons were given as to why participants did not believe that the town was adequately prepared. Many participants placed blame on the government for the town’s lack of preparedness, stating that the government does not provide enough resources and does not take adequate preventative measures. One participant stated that the government does not have an adequate risk prevention program, and that people may know about risks, but they do not know how to minimize them (Participant #6, personal communication, Nov. 13, 2018). Another participant claimed that the government needs to have a better emergency plan, and also emphasized the lack of resources in the area, including the fact that there is no permanent ambulance, no 24-hour health center, not enough firefighters, and no communal space to use as an emergency shelter if needed (Participant #10, personal communication, Nov. 15, 2018). Without these resources at hand, it is extremely difficult to plan for an emergency situation, and to handle one when it inevitably occurs. Additionally, multiple participants stated their concerns over the locations of many homes in Cerro Punta that they believe are built too close to the rivers and near steep hills, and called on the government to prevent people from living in these dangerous places. One participant stated that he believes the government should work with local NGOs like FUNDICCEP to relocate people who live in unsafe zones by building houses in safer areas. He stated they should also prevent people from building houses in dangerous locations in the first place (Participant #4, personal communication, Nov. 10, 2018).

Another common response from participants, that some even cited as the largest reason for the town’s unpreparedness, was the great “falta de conciencia” or lack of awareness of the issue of flooding within the community. This lack of awareness was described both as a lack of knowledge as well as a lack of attention and general disregard by various participants. For example, one participant stated that in cases of emergency, the people simply do not know what to do, and the authorities do not provide adequate assistance to the community (Participant #3, personal communication, Nov. 9, 2018). Participant 5 believed that the issue of flooding was not important enough in the minds of the people living in the town as well as the government (Participant #5, personal communication, Nov. 12, 2018). Participant 18 shared a similar sentiment, and said that not only does the lack of attention to the issue prevent people from taking adequate precautions, but it also contributes to issues like dumping of trees and trash into the rivers that, in her opinion, are such a large driver of the issue of flooding itself (Participant #18, personal communication, Nov. 19, 2018).

Interestingly, while a vast number of participants cited lack of awareness and lack of attention to the issue of flooding as a major reason for the unpreparedness of the community, this in and of itself shows an inconsistency. While many of the participants claimed that residents of
the town were not aware of the risks associated with flooding, the fact that this was such a common response could show that this may not be completely realistic. For example, while Participant 5 stated that he does not believe the issue is of great enough importance in the minds of Cerro Punta residents, 85% of participants in this study, almost all of whom reside in Cerro Punta, believed flooding to be an issue of increasing or high importance (Table 1). Reasons for this inconsistency could be due to error produced by the study methods. The sample of participants chosen was inherently not random, due to the nature of the convenience and snowball methods used. However, an effort was made to conduct interviews with residents from both varying areas of town and from varying professional backgrounds. If this inconsistency exists not only within the study sample, but also within the community at large, there could be greater reasons, beyond the study methods used, for this finding.

When it was noticed that the study questions may not be accurately capturing the perspectives of residents on preparedness, an additional question was added about whether the individual participant does anything to prepare for future disasters. It was hoped that this question would give a more realistic look at the issue of flooding and risk prevention in the minds of Cerro Punta residents. Two out of the seven participants who responded to this question answered that yes, they do prepare for future flooding. Both of these participants lived in the area of Bambito. Those who answered “no” lived in Guadalupe, Cerro Punta Centro, and Las Nubes. While Cerro Punta Centro was not cited as a very vulnerable area by participants, Las Nubes and Guadalupe were.

While residents may feel at risk of flooding, or may think that it is an important issue, they will not necessarily take measures to prepare for or prevent an emergency. The lack of awareness of the community in general felt by so many of the study participants may not necessarily be due to a lack of knowledge on the issue, but rather a lack of the capacity or willingness to act on that knowledge. As discussed in a study conducted in Cologne, Germany on what influences some people to take precautionary measures ahead of a disaster while some do not, raising the risk perception and awareness of individuals may not be enough to move them to act. Alternatively, social, economic, and personal factors that would prevent a person from taking responsibility for their safety have to be addressed (Grothmann and Reusswig 2006).

Table 4: Responses to question “Is Cerro Punta prepared to deal with potential future flooding?”
The number of participants who answered either yes or no is shown, as are the percentages of participants.

<table>
<thead>
<tr>
<th></th>
<th>Number of participants</th>
<th>Percent of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>1</td>
<td>5.56%</td>
</tr>
<tr>
<td>No</td>
<td>17</td>
<td>94.44%</td>
</tr>
</tbody>
</table>

Conclusion

While the residents of Cerro Punta interviewed had varying perceptions of flood risk, vulnerability, and preparedness, many commonalities were shared. Overall, the majority of residents interviewed felt that flooding is an issue of increasing concern in the area. Almost all interviewees cited deforestation, and issues surrounding deforestation such as erosion and the dumping of trees into rivers as major drivers of flooding. Many areas of Cerro Punta were
considered vulnerable to future flooding by residents, and as shown through ArcGIS, a significant number of buildings within Cerro Punta lie within close proximity to rivers. Additionally, concerns surrounding the disproportionate vulnerability of certain populations within Cerro Punta were voiced, namely the indigenous migrant worker population. Overall, residents of Cerro Punta do not feel prepared for potential future flooding, and many believe that it is the lack of resources available and a general lack of awareness that has created this unpreparedness.

Further research should be conducted on the differential vulnerability of certain segments of the population to flood hazards. Research could be conducted on the socioeconomic status of those people living closer to the rivers. Additionally, further research could examine the inconsistency between the lack of awareness of the community claimed by interviewees and the knowledge surrounding the issue of flooding that was found amongst residents interviewed. Whether this was a sampling error, and there truly is a lack of awareness about flooding, or whether the “lack” is actually in the capacity or willingness of residents to prepare for or prevent flooding could be explored.

It is important to understand community perceptions surrounding issues of natural disasters such as flooding, as oftentimes they can provide insight into the probability of future damage. Understanding how the community perceives risk can be the first step to managing and reducing the possibility and impacts of future disaster situations.


Appendices

A. Interview Guide

Semi-structured:

English:

1. How long have you lived in Cerro Punta?
2. What do you do?
3. What area of Cerro Punta do you live in? Could you show me on this map?
5. Do you believe that flooding is an issue of increasing importance in Cerro Punta?
6. What do you believe might be some of the drivers of flooding in the region?
7. On a scale of 1-10, how at risk do you think the community of Cerro Punta is for potential flooding in the future? Why?
8. On a scale of 1-10, how at risk do you feel your particular neighborhood and home is for potential flooding in the future? Why?
9. Do you think that people living in certain areas of town are more vulnerable to flooding than others?
10. Do you think that certain groups of people are more vulnerable to flooding than others?
11. Do you think that the town is prepared to deal with potential future flooding? Why or why not?
12. What are organizations, the government, and the community doing currently to help recover from past floods and prevent/prepare for potential future disasters?

Español:

1. ¿Por cuanto tiempo ha vivido en Cerro Punta?
2. ¿A qué se dedica?
3. ¿En qué área de Cerro Punta vive usted? ¿Puede mostrarme en este mapa?
5. ¿Cree que las inundaciones son un problema de creciente importancia en Cerro Punta?
6. ¿Qué cree que podrían ser algunos conductores de inundaciones en la región?
7. ¿En una escala del 1 al 10, cuál es el grado de riesgo de inundaciones en el futuro en la comunidad? ¿Porqué?
8. ¿En una escala del 1 al 10, cuál es el grado de riesgo de inundaciones en el futuro en el barrio suyo o casa suyo? ¿Porqué?
9. ¿Piensa que la gente que vive en algunas áreas en particular es más vulnerable a las inundaciones que otros?
10. ¿Piensa que algunos grupos de personas en particular son más vulnerables a las inundaciones que otros?
11. ¿Piensa que Cerro Punta está preparado a lidiar con inundaciones futuras potenciales? ¿Porqué sí o no?
12. ¿Qué hacen el gobierno, la comunidad, y las organizaciones en este momento a recuperar de las inundaciones y prevenir desastres en el futuro?

Unstructured:

English:

1. Background questions: How long have you lived in Cerro Punta? What is your profession? What area do you live in?
2. Did you experience flooding in 2008, 2014, and/or 2018?
3. Do you believe that flooding is an increasing issue in Cerro Punta? What do you believe might be some of the causes of this?
4. How at risk do you feel the community is for potential future flooding? How at risk do you feel your area specifically is?
5. Do you think that people living in certain areas of town are more vulnerable to flooding than others?
6. Do you think that the town is prepared to deal with potential future flooding? Why or why not?
7. *Do you personally do anything to prepare for potential future flooding events?

En español:

1. ¿Por cuanto tiempo ha vivido en Cerro Punta? ¿A qué se dedica? ¿En qué área de Cerro Punta vive usted? ¿Puede mostrarme en este mapa?
3. ¿Cree que las inundaciones son un problema de creciente importancia en Cerro Punta?
4. ¿En una escala del 1 al 10, cuál es el grado de riesgo de inundaciones en el futuro en la comunidad? ¿Porqué?
5. ¿En una escala del 1 al 10, cuál es el grado de riesgo de inundaciones en el futuro en el barrio suyo o casa suyo? ¿Porqué?
6. ¿Piensa que Cerro Punta está preparado a lidiar con inundaciones futuras potenciales? ¿Porqué sí o no?
7. *¿Usted hace algo para preparar para las inundaciones potenciales en el futuro?

*This question was added halfway through the study.
B. Informed Consent Guide

English:

My name is Julia Stanganelli and I’m a student with the School for International Training program in Panama. Would you be willing to participate in a study I am conducting on the perceptions of flood risk amongst residents of Cerro Punta? Your participation is entirely voluntary.

The purpose of the study is to examine flood risk from the perspectives of residents of Cerro Punta. Your participation will consist of answering 5-10 questions and will take about 30 minutes of your time.

There are no foreseeable risks to participating in this study, and no penalties should you choose not to participate. Again, it is completely voluntary. During the interview, you have the right not to answer any questions that you don’t want to, and you can stop participating at any time. There will be no compensation for participation in this study.

Your name will not be asked, and any identifiable information obtained in connection with this study will remain confidential. No one will have access to the data used in this study besides me and my advisor, and it will not be used for any future purposes. If the research is published, no identifiable information will be used.

Do you give your consent to participate in this study?
Do you give your consent to be quoted in this study?
Do you give your consent for this interview to be recorded?

If you have any questions or want more information about this study, please contact me at jas7ua@virginia.edu, or my advisor at aly.dagang@sit.edu.

In an endeavor to uphold the ethical standards of all SIT proposals, this study has been reviewed and approved by an SIT Study Abroad Local Review Board or SIT Institutional Review Board. If you have any questions, concerns, or complaints about your rights as a research participant or the research in general and are unable to contact me, please contact the Institutional Review Board at:

School for International Training
Institutional Review Board
1 Kipling Road, PO Box 676
Brattleboro, VT 05302-0676 USA
irb@sit.edu
802-258-3132

Español:
Me llamo Julia Stanganelli y soy un estudiante con SIT, la escuela para formación internacional en Panamá. ¿Estaría dispuesto a participar en un estudio que yo estoy conduciendo sobre las percepciones del riesgo de inundaciones entre los residentes de Cerro Punta? Su participación es totalmente voluntaria.

El objeto de este estudio es a examinar el riesgo de inundación desde los perspectivos de residentes de Cerro Punta. Su participación consiste en responder a cinco a diez preguntas, y tomará más o menos de treinta minutos de su tiempo.

No hay ningunes riesgos previsibles a participar en este estudio, y no penalizaciones si usted no quiere participar. Un otra vez, es totalmente voluntario. Durante la entrevista, tiene la derecha a no responder a algunas preguntas que usted no quiere responder, y también puede terminar a algún tiempo. No hay compensación para participar en este estudio.

No preguntaré su nombre, y alguna información identificable obtenido en conexión con este estudio permanecerá confidencial. Nadie tendrá acceso a la data usado en este estudio excepto yo y mi consejero, y no usaré por ningunes usos en el futuro. Si esta investigación está publicada, no información identificable será usado.

¿Da tu consentimiento para participar en este estudio?
¿Da tu consentimiento para ser citado en este estudio?
¿Da tu consentimiento para que yo grabe esta entrevista?

Si tiene alguna pregunta o quiere más información de este estudio, puede contactarme a jas7ua@virginia.edu, o mi consejero a aly.dagang@sit.edu.

En un esfuerzo por defender los estándares éticos de todas las propuestas de SIT, este estudio ha sido revisado y aprobado por una Junta de Revisión Local de SIT Study Abroad o Junta de Revisión Institucional de SIT. Si tiene alguna pregunta, inquietud o queja sobre sus derechos como participante de la investigación o la investigación en general y no puede comunicarse conmigo, puede comunicarse con la Junta de Revisión Instucional al:

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